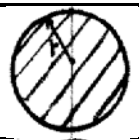
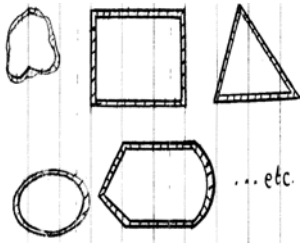
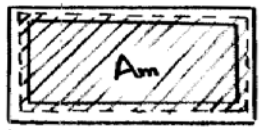
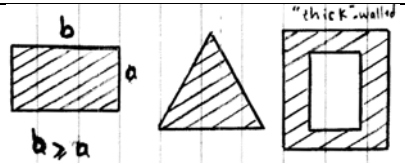
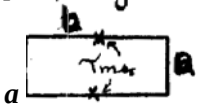
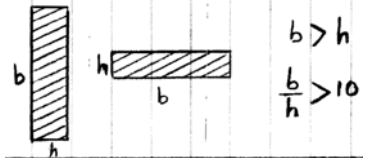
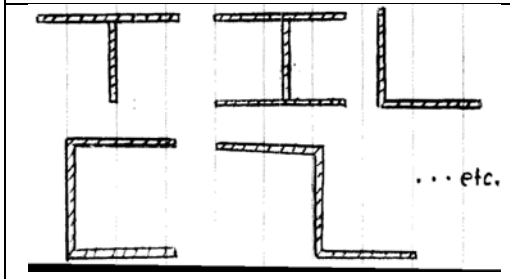
Summary ((Torsion))

Shape	Name	τ	$d\phi/dz$	ϕ	J	Remarks
	**solid circular**	$\frac{Tr}{J}$	$\frac{T}{JG}$	$\frac{TL}{JG}$	$\frac{\pi}{2} r^4$	• τ_{max} @ $r_{max} = r_{out}$
	**hollow circular**	$\frac{Tr}{J}$	$\frac{T}{JG}$	$\frac{TL}{JG}$	$\frac{\pi}{2}(r_o^4 - r_i^4)$	• τ_{max} @ $r_{max} = r_{out}$
	**thin-walled closed**	$\frac{T}{2t\,A_m}$	$\frac{T}{4\,GA_m^2}\sum_{i=1}^{n}\frac{S_i}{t_i}$	$\frac{TL}{4\,GA_m^2}\sum_{i=1}^{n}\frac{S_i}{t_i}$	N.A.	• **A_m = area contained within mean perimeter (<u>not</u> material area)** e.g.  • τ_{max} @ t_{min}
	**solid noncircular**	depends on shape $\frac{T}{\alpha\, b\, a^2}$ for rectangle	depends on shape $\frac{T}{\beta\, b\, a^3\, G}$ for rectangle	depends on shape $\frac{TL}{\beta\, b\, a^3\, G}$ for rectangle	N.A.	For rectangular section, • formula given for τ_{max} at midpoint of long side  * **$b \geq a$**
	**narrow rectangle**	$\frac{Th}{J}$	$\frac{T}{JG}$	$\frac{TL}{JG}$	$\frac{1}{3} bh^3$	• b > > h • **b/h > 10** • formulas similar to circular sections except J
	**series of narrow rectangles ((section composed of several long narrow rectangles))**	$\frac{Th_i}{J}$	$\frac{T}{JG}$	$\frac{TL}{JG}$	$\sum_{i=1}^{n} J_i$ $J_i = \frac{1}{3} b_i h_i^3$	• **τ_{max} @ h_{max}** • **h is the smaller dimension in each segment.** • formulas similar to circular and narrow rectangular sections except $J_i = \sum_{i=1}^{n} \frac{1}{3} b_i h_i^3$ n = number of segments